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**FR-A- 2 576 393**
**GB-A- 2 149 079**
**US-A- 2 205 638**
**US-A- 3 948 714**
**US-A- 4 510 560**
**US-A- 4 805 984**

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## Description

### Technical Field

The present invention is directed to an apparatus for transporting and reflecting light, particularly to a pole light adapted to reflect light in a broad, uniformly distributed pattern. The present invention is also directed to a reflective sheeting material for use in an apparatus for transporting and reflecting light.

### Background of the Invention

The illumination of roadways, parking lots, outdoor sports facilities, and the like, is typically accomplished by means of directed light sources suspended at the top of tall poles. For example, pole lights are commonly found uniformly positioned along city streets and highways.

A pole light typically includes a light source suspended at the top of a tall pole, typically 15 to 18 meters above the ground. A light is typically encased in a fixture having reflective and/or refractive portions used to direct the light to the ground below in a desired pattern. The fixture may also include a transformer or ballast, wiring, and other components necessary to provide a bright directed source of light at the top of a pole. The light and fixture typically are very heavy. Accordingly, to suspend the light and the light fixture, a heavy pole, typically made of a heavy gauge metal, is required.

Pole lights are positioned at uniform intervals, for example, along a highway or other roadway. The brightness of the light source, the characteristics of the reflectors and/or refractors contained in the fixture, the height that the light source is positioned above the ground, and the distance between adjacent light poles, all contribute to the intensity and pattern of the light illuminating the ground or other surface surrounding the pole. The uniformity of the light illuminating the ground is quantified by the ratio of illumination, defined as the ratio between the brightest spot and the darkest spot. A 7:1 ratio of illumination is considered fairly uniform, while ratios of 100-1000:1 are not uncommon. A ratio of illumination of less than 3:1 would be highly desirable.

Standard pole lights, having a directed light source suspended above the ground, present problems involving cost, maintenance, and safety. Because of the materials required to suspend the heavy light and fixture above the ground, the cost of such light poles can be significant. Maintenance of such pole lights is also costly and time consuming. To change a light bulb in a suspended light fixture, it is necessary to use a lifting device, such as a telescoping man lift or hoist, attached to a highway maintenance vehicle. In addition to the cost of the two or three persons necessary to operate the lift truck, the presence of such a vehicle on the side of a roadway can be dangerous, both to the maintenance personnel and to the motorist. The presence of the poles themselves along a roadway also presents the danger of the pole being struck by a motorist. Because such poles are typically heavy gauge metal, the impact with such a pole can have severe consequences. In addition, the heavy light fixture and the heavy metal pole, present a significant danger in falling subsequent to impact by a vehicle.

In a different technical field, light conduits capable of transmitting large quantities of light energy from one place to another are known. Such light transmitting conduits are useful in a wide variety of applications, for example, in transmitting sunlight from outdoors into the interior of a room. Such light conduits typically operate on the principle of total internal reflection, having a plurality of 45° angle prisms extending the length of the conduit to totally internally reflect the light as it travels along the length of the conduit. See, for example, U.S. Patent Nos 4,260,220; 4,805,984; 4,750,789; and 4,615,579.

In view of the disadvantages inherent in the presently known light poles, there is a need for an apparatus that transports light from a light source that can be located at or near ground level upward to a reflecting member, that distributes the light uniformly to the ground below. FR-A-2 576 393 discloses an apparatus for transporting light upwards from a light source to a reflecting member of an unspecified nature. The described apparatus is likely to provide for a non-uniform distribution of reflected light. There is also a need for a reflective sheeting material that may, for example, be provided in a reflection chamber adapted to be provided at the top of a light conduit to reflect an area source of light emitted from the light conduit in a broad, uniformly distributed pattern.

GB-A-2 149 079 discloses a light fitting which includes a stepped reflective surface for reflecting downwardly the light shining upwardly from a light source constrained within the light fitting. The specifications of the stepped reflective surface are not described. In one embodiment the reflective surface consists of adjustable bladed louvre reflectors which is likely to provide for a non-uniform distribution of reflected light.

US-A-2 205 638 describes a reflecting device in which the reflective area is composed of a series of contiguous successive rows of square-face triple-reflector units. US-A-3 948 714 also discloses a reflector of the type having a plurality of cube-corner reflector units on the back of the reflector.

Both of these cube-corner reflectors rely on total internal reflection to achieve retroreflectivity.

## Disclosure of Invention

The present invention provides a reflective sheeting material having a structured, reflective surface comprising a linear array of isosceles prism reflecting elements, the elements including a pair of reflective surfaces having an angle of about 120° therebetween. Each reflecting surface also forms a reflective groove with an adjacent reflective surface, the surfaces of the groove having an angle of about 120° therebetween.

The present invention also provides a reflective sheeting material having a structured reflective surface comprising an array of reflecting elements comprising a polyhedron having three parallelogram faces. The elements are shaped and arranged so that the following conditions exist: (a) the faces intersect at three external lines of intersection and at an element apex; (b) each face also intersects with adjacent faces on two adjacent elements; (c) the three faces on three adjacent elements intersect along three internal lines of intersection forming a reflection valley; and (d) in use, a ray of incident light entering a valley strikes a face at an angle of about 33°-37° and reflects from the face approximately parallel to the other two faces and at an angle of about 67°-74° from the incident light.

The present invention also provides an apparatus, such as a light pole, for transporting light and reflecting the light in a broad, uniform pattern. The apparatus comprises (a) a columnar light conduit, for transporting light therealong, the conduit having a proximate end and a distal end; (b) a light source provided at the proximate end of the light conduit; and (c) a light distributing reflective member, such as the reflective sheeting material described above, comprising an array of repeating reflecting elements. The reflective member is positioned at the distal end of the light conduit so that the light exiting the distal end of the conduit is reflected in a broad, uniformly distributed pattern.

The present invention also provides a reflection chamber adapted to reflect an area source of light, such as from a light conduit, in a broad, uniformly distributed pattern. The reflection chamber comprises (a) a light inlet; (b) a reflecting member including a reflective sheeting material, such as those described above; and (c) at least one transparent wall portion to allow the reflected light to exit the reflection chamber.

## Brief Description of the Drawings

Fig. 1 is a fragmentary, plan view of one embodiment of the reflective sheeting material of the invention;

Fig. 2 is a vertical section of a reflective sheeting material like that shown in Fig. 1;

Figs. 3A and B are top views of two embodiments including reflective sheeting material of the invention;

Fig. 4 is a schematic view of a reflective sheeting material of the invention and the footprint of light reflected from such material;

Fig. 5 is a schematic view of a reflective sheeting material of the invention and a footprint of reflected light from such sheeting material through a diffuser;

Fig. 6 is a fragmentary top view of an embodiment of reflective sheeting material of the invention;

Fig. 7 is a fragmentary perspective view showing three polyhedron reflecting elements of the reflective sheeting material of Figure 6;

Fig. 8 is a sectional view along the plane A-B-C-D of Fig. 7; and

Fig. 9 is a schematic cross-section of a light pole of the invention.

## Detailed Description of the Present Invention

Referring to Fig. 1, a reflective sheeting material 10 is shown having a linear array of reflecting elements 12. The elements 12 each include a pair of reflective surfaces 14, each reflective surface 14 forming a reflective groove 16 with an adjacent reflective surface 14.

Referring to Fig. 2, a cross-section of a reflective sheeting material 20 is shown. The sheeting material 20 includes. reflective elements 22 each having reflective surfaces 24. The reflective surfaces 24 form a reflective groove 26 therebetween. The angle between reflective surfaces 24 is "A." An incident ray 27 normal to the plane of the sheet material 20 strikes a reflective surface 24 and is reflected along reflected ray 28 parallel to the adjacent surface 24, at an angle "B" with the incident ray 27, and at an angle "C" with the plane of the sheet material 29.

Referring to Fig. 3A, a reflective member 30 is shown having reflective sheeting portions 32, 34, 36, and 38. The reflective sheeting portions each contain a plurality of reflective grooves 40.

Referring to Fig. 3B, a reflective member 45 is shown having reflective sheeting portions 46, 48, 50, and 52. The reflective sheeting portions 46, 48, 50, and 52 include a plurality of reflective grooves 54.

Referring to Fig. 4, a reflective member 60 is shown. The footprint portions 62 represent light reflected from the reflective member 60.

Referring to Fig. 5, a reflective member 70 is shown. The footprint 72 represents the light reflected from the reflective member 70 with the light passing through a diffuser.

Referring to Fig. 6, a reflective sheeting material 80 is shown. The sheeting material 80 includes a plurality of reflecting elements 82, each comprising faces 84, 84' and 84". Faces 84, 84', 84" intersect along external lines of intersection 86, 86,, 86", the lines of intersection intersecting at an element apex 88. Each face 84, 84', or 84" intersects with an adjacent face 84, 84', or 84" on two adjacent elements 82 along three internal lines of intersection 90, 90', 90", forming a reflection valley 92.

Referring to Figs. 7 and 8, in use, a ray of incident light 100 strikes a reflective face 84, 84', or 84" and is reflected along a reflected ray 102. The face 84 is at an angle a with the plane of the reflective sheeting material 104. The reflected ray 102 is reflected at an angle $\beta$ with the plane of reflective sheeting material 104.

Referring to Fig. 9, a pole light 120 is shown. The pole light 120 includes a columnar light conduit 122, a light source 124, and a reflection chamber 126. The reflection chamber 126 includes a light inlet 128, a reflecting member 130, sidewall portions 132, and bottom wall portions 134. The reflecting member 130 includes a plurality of reflecting elements 136. The columnar light conduit 122 includes a distal end 138, a proximate end 140, and a light transporting sheeting material 142. The light source 124 includes a light bulb 144. The light source 124 and the proximate end 140 of the conduit 122 is provided in a base portion 150. The base portion 150 includes an access box 152, having a door 153 and an access opening 154.

Reflective Sheeting Material

The reflective sheeting materials of the present invention are configured to reflect light in a broad, uniform pattern. The present invention provides two types of reflective sheeting material, one including a linear array of isosceles prism reflecting elements, and the second including an array of reflecting polyhedron elements, each having three parallelogram faces.

The isosceles prism reflecting elements form an angle of about 30° with the plane of the sheeting material. Thus, a ray of light will be reflected at an angle of 30° to the horizontal, and parallel to the adjacent face of an adjacent element.

The reflective sheeting material having polyhedron reflecting elements includes an array of reflection valleys formed by three faces of adjacent elements. A ray of incident light strikes a face of a reflection valley at an angle of about 33° - 37°, and reflects from the face approximately parallel to the other two faces, and at an angle of about 67° - 74° from the incident light. Thus, the reflected ray is reflected at an angle of about 16° - 23° below the horizontal.

The polyhedron sheeting material preferably comprises elements each having three rhombus faces and being shaped and arranged so that the following conditions exist:

a) the faces intersect at three external lines of intersection and at an element apex;

b) the external lines of intersection each intersect at the apex at equal angles;

c) each rhombus face also intersects with adjacent faces on two adjacent elements;

d) the three rhombus faces of three adjacent elements intersect along three internal lines of intersection forming a reflection valley;

e) each rhombus face forms an angle, alpha, with the plane of the sheet material, alpha being about 33° - 37°;

f) in use, a ray of incident light normal to the plane of the sheet material reflects from one of the three faces of a valley approximately parallel to the other two faces of the valley; and

g) the angle, beta, between a ray of reflected normal incident light and the plane of the sheet material is about 16° - 23°.

It is preferred that the angle $\alpha$ be about 35° - 36°, and that $\beta$ be about 19° - 20°. It is also preferred that the sheeting material have an effective aperture of about 100%. When $\alpha$ = 35.3° and $\beta$ = 19.5° the reflective sheeting material exhibits 100.0% aperture to normal rays. Typically in use, the angle $\beta$ is the angle below the horizontal at which the light is reflected. A typical pole light will transport light in a path perpendicular to the ground. The plane of the reflective sheeting material is thus positioned so as to be approximately parallel to the ground. Light is reflected from the sheeting material back towards the ground at an angle $\beta$ below the horizontal plane of the sheeting material. The smaller the angle ($\beta$) below the horizontal at which the light is reflected, the further the light can be spread from the pole.

The reflective sheeting material of the present invention may be made from any suitable material. The structured reflective surface of the sheeting material is made from a suitable reflective material. Thus, the entire reflective material can be formed from aluminum or steel, that can be polished to provide a structured reflective surface. However, it is preferred that the reflective material be formed from a plastic material having a structured surface of the desired shape, with the structured surface

metalized, such as vapor coated aluminum, to provide the reflective surface.

A suitable plastic material for forming the reflective sheeting material is preferably dimensionally stable, durable, weatherable, and readily formable into the desired configuration. Examples of suitable materials include acrylics, such as Plexiglass resin from Rohm and Haas; polycarbonates; polyethylene based ionomers, commercially available as "Surlyn", from E.I. DuPont de Nemours & Co.; polyesters; and cellulose acetate butyrates. The polymer may be clear or opaque as light is not transmitted therethrough, but is reflected from the reflectorized structured surface.

The reflective sheeting material may be prepared in a variety of ways including embossing, casting, stamping, or by other means of forming materials, in or with a transparent plastic material. After the structured surface has been formed in one planar surface of a plastic or other material, the surface can be metalized utilizing, a number of suitable metals, such as aluminum.

Reflection Chamber

The reflective sheeting material of the present invention is preferably provided in a reflection chamber adapted to be placed at the top of a light conduit to reflect an area source of light, emitted from the top of the light conduit, into a broad, uniformly distributed pattern. The reflection chamber may be designed in a wide variety of configurations to provide the desired footprint or pattern of light reflected onto the ground or other surface below the pole light. The reflective sheeting material is placed opposite the distal end of the light conduit with the structured reflective surface facing the light conduit so that the light exiting the light conduit is reflected in a broad, uniformly distributed pattern.

The reflecting member includes one or more portions of a reflective sheeting material arranged so as to reflect light into a desired footprint. For example, as shown in Figs. 3A and 3B, the reflecting member may include four portions with the grooves of each portion aligned in a non-linear relation.

The reflection chamber also includes a light inlet adapted to engage the distal end of the light conduit and provide an opening into the reflection chamber to allow the area source of light being emitted from the distal end of the light conduit to radiate into the reflection chamber. The reflection chamber includes at least one transparent wall portion to allow the reflected light to exit the reflection chamber. The reflection chamber may be circular, square, triangular, hexagonal, octagonal, or any of a number of other shapes as desired. Thus, a wall portion may be a sidewall portion, a bottom wall portion, or other portion of the reflection chamber. For example, a wall portion may be a portion of the circumference of a circle or other shape. For example, if the pole light were designed to be used in a parking lot where light was to be reflected in all directions, the reflection chamber could be designed to have transparent walls on all sides.

The reflection chamber may also include one or more planar reflector wall portions for directing light in a desired direction. For example, for use along a roadway it is desirable to reflect the light being reflected from the reflecting member towards the roadway and not behind the pole light or along the side of the roadway. Thus, planar reflection surfaces may be provided so as to reflect light in a given direction.

In addition, diffusing wall panels may be provided to diffuse the light reflected from the reflective member into a more uniformly distributed pattern on the ground below (Fig. 5). These and other methods of reflecting and refracting light into desired patterns may be utilized in the reflection chamber to provide the desired footprint of light reflected from the reflective member.

Light Conduit

Totally internally reflecting conduits for transporting light from one place to another are known in the art. U.S. Patent No. 4,805,984 (the '984 patent) describes such a light conduit and is incorporated herein by reference. See also, U.S. Patent Nos. 4,615,579 and 4,750,798.

In use, a light conduit transports light from a light source, including both artificial or solar energy, and transports the light from one end of the conduit to the other. Light conduits, such as those described in the '984 patent, can transport light with very little loss of light. In addition, the light provided at the distal end of a conduit, such as that described in the '984 patent, is a linearly directed (semicolumnated) area source of light. An area source of light is made up of a large number of point sources of light. Thus, a single light bulb or multiple light bulbs at the proximate end of the light conduit will provide an integrated area source of light at the distal end of the conduit. The integrated area source is then reflected by the array of reflecting elements into a broad, uniformly distributed pattern.

Although there are a number of configurations of light conduits known in the art, light conducts such as those described in the '984 patent are preferred. A preferred light conduit will comprise a wall member of a transparent material, including a structured surface on one side and a smooth surface opposite the structured surface. At least a

portion of the cross-section of the wall member lying in a smooth arcuate curve. For example, the wall member may have a substantially circular cross-section with the smooth surface disposed on the inner side of the wall member and the structured surface on the outside of the wall member. The structured surface includes a linear array of substantially right angled isosceles prisms arranged side-by-side, with the perpendicular sides of the prisms making an angle of approximately 45° with the tangent to the smooth surface opposite of the structured surface. The prisms typically run parallel to the axis of the wall member extending continuously from one end to the other. In use, a predetermined portion of the light entering the light conduit within an acceptable angular range, is contained by total internal reflection as it travels along from the proximate end to the distal end of the light conduit.

Pole Light

The present invention also provides an apparatus for transporting light and reflecting the light in a broad, uniform pattern. Such an apparatus may be used as, for example, a pole light positioned along a roadway, highway, or a parking lot. A pole light will include a light source typically provided in a base portion. The base portion is adapted to be positioned either submerged in, or on top of, the ground. A columnar light conduit, such as that described in the ,984 patent, extends from the base portion, typically positioned so as to extend vertically from the ground. It is preferable that the base portion include an accessible box portion for ease of access to the light source. The light source may include one or more light bulbs or other sources of light. Thus, the light bulb or bulbs may be easily replaced by one person, without the need for ladders, hoists, or other apparatus typically required to change a bulb positioned on top of a pole light.

The light emitted from the light source at the base or proximate end of the light conduit is transported through the light conduit and is provided as an area source of light at the distal end of the light conduit. The light could also be located elsewhere in the light conduit, as desired, and proximate end, as used herein, will refer to the end of that portion of light conduit where the light source is located.

A light distributing reflective member comprising an array of repeating reflective elements is positioned at the distal end of the light conduit so that the light exiting the distal end of the conduit is reflected in a broad, uniformly distributed pattern. Examples of light distributing reflective members include the reflective sheet materials described herein. The reflective member may comprise two or more linear arrays of reflecting elements disposed in different linear relation to reflect the light into a particular uniformly distributed pattern. (For example, see Figs. 3A and 3B.)

The reflective member is typically provided in a reflection chamber which further aids in the reflection and refraction of the reflected light into a desired footprint. By selecting suitable combinations of reflecting elements, planar reflectors, and defusing panels, a wide variety of broad, uniformly distributed patterns of light or footprints may be provided. Footprint refers to the pattern of light that is projected on the ground or other surface surrounding the pole.

By use of the apparatus of the present invention and positioning such apparatus, or pole lights, in groups or clusters, the ratio of illumination that can be obtained is superior to that previously known. Ratios of illumination of 7:1 have previously been considered quite uniform. Ratios of illumination of 100 - 1000:1 are not uncommon. A group of light poles of the present invention can be designed so as to provide a ratio of illumination of less than about 3:1, and can be made to provide a ratio of illumination of less than about 2:1.

In addition to providing superior ratios of illumination to known pole lights, pole lights of the present invention are able to be made of plastic materials, instead of metal, thereby providing savings of cost, and providing increased safety to, for example, the motorist. In addition, pole lights of the present invention can be made to be approximately 6 meters tall compared to previous pole lights, typically 15 - 18 meters in height, and produce comparable footprints.

An added feature that can be provided as part of the apparatus of the invention is a light emitting opening provided in the wall member of the light conduit. The light emitting opening or openings can be provided in the shape of letters, words, or other shapes. For example, "EXIT" can be illuminated in the side wall of a pole positioned at an exit ramp on a highway. The loss of light from such an opening can be minimal, with a sufficient quantity of light remaining to be reflected by the reflecting element.

**Claims**

1. A specularly reflective sheeting material 10 having a structured reflective surface comprising a linear array of isosceles prism reflecting elements 12, each of said elements including a pair of reflective surfaces 14 having an angle of about 120° therebetween, each reflective surface also forming a reflective groove 16 with an adjacent reflective surface, the surfaces of said groove having an angle of about

120° therebetween.

2. A specularly reflective sheeting material 80 having a structured reflective surface comprising an array of reflecting elements 82, each of said elements comprising a polyhedron having three parallelogram faces 84, 84', 84", and being shaped and arranged so that the following conditions exist:
   a. said faces intersect at three external lines of intersection 86, 86', 86" and at an element apex 88;
   b. each face also intersects with adjacent faces on two adjacent elements;
   c. three faces on three adjacent elements intersect along three internal lines of intersection 90, 90', 90" forming a reflection valley 92; and
   d. in use, a ray of incident light 100 entering the valley 92 and striking a face of the three faces at an angle of about 33° - 37° is reflected from the face approximately parallel to the other two faces of the valley and at an angle of about 67° - 74° to the incident light.

3. The sheeting material 80 of claim 2 wherein each of said elements 82 comprises a polyhedron having three rhombus faces 84, 84', 84" and being shaped and arranged so that the following conditions exist:
   a. said rhombus faces intersect at three external lines of intersection 86, 86', 86" and at an element apex 88;
   b. said external lines of intersection each intersect at the apex at equal angles;
   c. each rhombus face also intersects with adjacent faces on two adjacent elements;
   d. the three rhombus faces of three adjacent elements intersect along three internal lines of intersection 90, 90', 90" forming a reflection valley 92;
   e. each rhombus face forms an angle, $\alpha$, with the plane of the sheet material, $\alpha$ being 33° - 37°;
   f. in use, a ray of incident light 100 normal to the plane of the sheeting material reflects from one of the three faces of the valley approximately parallel to the other two faces of the valley; and
   g. the angle, $\beta$, between a ray of reflected normal incident light 102 and the plane of the sheeting material is about 16° - 23°.

4. The sheeting material of claim 3 wherein $\alpha$ is about 35° - 36° and $\beta$ is about 19° - 20°.

5. A reflection chamber 126 adapted to reflect an area source of light in a broad, uniformly distributed pattern, said chamber comprising:
   a. a light inlet 128;
   b. a reflecting member 130 including a reflective sheeting material of claim 1 or 2; and
   c. at least one transparent wall portion 134 to allow the reflected light to exit the reflection chamber.

6. An apparatus 120 for transporting light and reflecting the light in a broad, uniform pattern, said apparatus comprising:
   a. a columnar light conduit 122, for transporting light there along, said conduit having a proximate end 140 and a distal end 138;
   b. a light source 144 provided at the proximate end of the light conduit; and
   c. a light distributing reflective member 130 comprising at least one portion of reflective sheeting material of claim 1, said reflective member positioned at the distal end 138 of said light conduit 122 so that the light exiting the distal end of the conduit is reflected in a broad, uniformly distributed pattern.

7. The apparatus 120 of claim 6 wherein said columnar light conduit 122 for transporting light there along comprises a wall member of a transparent material, said wall member including a structured surface on one side and a smooth surface opposite said structured surface on the other side, at least a portion of the cross-section of said wall member lying in a smooth arcuate curve, said structured surface having a linear array of substantially right angled isosceles prisms arranged side-by-side, the perpendicular sides of said prisms making an angle of approximately 45° with the tangent to said smooth surface opposite said structured surface, so that a predetermined portion of the light entering the light conduit within an acceptable angular range is contained by total internal reflection as it travels along from the proximate end 140 to the distal end 138 of the light conduit.

8. The apparatus of claim 7 wherein said wall member is substantially circular in cross-section and said smooth surface is disposed on the inner side of said wall member and said prisms run parallel to the axis of said wall member.

9. The apparatus 120 of claim 6 wherein said reflective member 130 comprises two or more

portions 32, 34, 36, 38 of said reflective sheeting material in which the grooves 40 of the linear array of reflective elements of one of said reflective sheeting portions 38 are aligned in a non-parallel relationship to the grooves of an array of another portion 36 in order to reflect light in a uniformly distributed pattern.

10. An apparatus 120 for transporting light and reflecting the light in a broad, uniform pattern, said apparatus comprising:
    1. a columnar light conduit 122, for transporting light there along, said conduit having a proximate end 140 and a distal end 138;
    2. a light source 144 provided at the proximate end of the light conduit; and
    3. a light distributing reflective member 130 comprising a specularly reflective sheeting material in accordance with claim 2, said reflective member being positioned at the distal end of said light conduit so that the light exiting the distal end of the conduit is reflected in a broad, uniformly distributed pattern.

11. The apparatus 120 of claim 10 in which the light distributing reflective member 130 comprises a reflective sheeting in accordance with claim 3.

12. The apparatus 120 of claim 6 or 10 which is a light pole having a light source 144 provided in a base portion 150 adapted to be on top of or submerged in the ground with the columnar conduit 122 extending vertically from the ground.

**Patentansprüche**

1. Spiegelnd reflektierendes Folienmaterial (10) mit einer strukturierten reflektierenden Oberfläche, umfassend eine lineare Anordnung von reflektierenden Elementen (12) in Form gleichschenkliger Prismen, wo jedes dieser Elemente ein Paar reflektierender Oberflächen (14) aufweist, die einen Winkel von etwa 120° einschließen, wobei jede reflektierende Oberfläche auch eine reflektierende Furche (16) mit einer angrenzenden reflektierenden Oberfläche bildet und die Oberflächen der Furche einen Winkel von etwa 120° einschließen.

2. Spiegelnd reflektierendes Folienmaterial (80) mit einer strukturierten reflektierenden Oberfläche, umfassend eine Anordnung von reflektierenden Elementen (82), die jeweils ein Polyeder mit drei Parallelogrammseiten (84, 84', 84") umfassen und so geformt und angeordnet sind, daß die folgenden Bedingungen gelten:
    a) die Seiten schneiden sich an drei äußeren Schnittlinien (86, 86', 86") und an der Spitze (88) des Elementes;
    b) jede Seite schneidet sich auch mit angrenzenden Seiten an zwei benachbarten Elementen;
    c) drei Seiten an drei benachbarten Elementen schneiden sich entlang drei inneren Schnittlinien (90, 90', 90"), die eine reflektierende Furche (92) bilden; und
    d) im Gebrauch wird ein einfallender Lichtstrahl (100), der in die Furche (92) eintritt und auf eine Seite der drei Seiten in einem Winkel von etwa 33° - 37° auftrifft, von der Seite ungefähr parallel zu den anderen beiden Seiten der Furche und in einem Winkel von etwa 67° - 74° zum einfallenden Licht reflektiert.

3. Folienmaterial (80) nach Anspruch 2, bei dem jedes der Elemente (82) ein Polyeder mit drei Rhombenseiten (84, 84', 84") umfaßt und so geformt und angeordnet ist, daß die folgenden Bedingungen gelten:
    a) die Rhombenseiten schneiden sich an drei äußeren Schnittlinien (86, 86', 86") und an der Spitze (88) des Elementes;
    b) die äußeren Schnittlinien schneiden sich jeweils an der Spitze in gleichen Winkeln;
    c) jede Rhombenseite schneidet sich auch mit angrenzenden Seiten an zwei benachbarten Elementen;
    d) die drei Rhombenseiten von drei benachbarten Elementen schneiden sich an drei inneren Schnittlinien (90, 90', 90"), die eine reflektierende Furche (92) bilden
    e) jede Rhombenseite bildet einen Winkel $\alpha$ mit der Ebene des Folienmaterials, wobei $\alpha$ 33° - 37° beträgt;
    f) im Gebrauch wird ein senkrecht zu der Ebene des Folienmaterials einfallender Lichtstrahl (100) von einer der drei Seiten der Furche ungefähr parallel zu den beiden anderen Seiten der Furche reflektiert; und
    g) der Winkel $\beta$ zwischen einem reflektierten, senkrecht einfallenden Lichtstrahl (102) und der Ebene des Folienmaterials beträgt etwa 16° - 23°.

4. Folienmaterial nach Anspruch 3, bei dem $\alpha$ etwa 35° - 36° und $\beta$ etwa 19° - 20° beträgt.

5. Reflexionskammer (126), die eine Flächenlichtquelle in einem breiten, gleichmäßig verteilten Muster reflektieren kann, wobei die Kammer folgendes umfaßt:
    a) einen Lichteinlaß (128);

b) ein reflektierendes Element (130) mit einem reflektierenden Folienmaterial nach Anspruch 1 oder 2; und
c) mindestens einen durchlässigen Wandabschnitt (134), durch den das reflektierte Licht die Reflexionskammer verlassen kann.

6. Vorrichtung (120), die das Licht leitet und in einem breiten, gleichmäßigen Muster reflektiert, wobei die Vorrichtung folgendes umfaßt:
a) einen säulenartigen Lichtleiter (122), an dem entlang des Licht befördert wird, wobei der Lichtleiter ein proximales Ende (140) und ein distales Ende (138) aufweist;
b) eine Lichtquelle (144) am proximalen Ende des Lichtleiters; und
c) ein lichtverteilendes reflektierendes Element (130) mit mindestens einem Abschnitt aus reflektierendem Folienmaterial nach Anspruch 1, wobei das reflektierende Element am distalen Ende (138) des Lichtleiters (122) positioniert ist, so daß das am distalen Ende des Lichtleiters austretende Licht in einem breiten, gleichmäßig verteilten Muster reflektiert wird.

7. Vorrichtung (120) nach Anspruch 6, bei der der säulenartige Lichtleiter (122) zur Beförderung des Lichtes ein Wandelement aus einem durchlässigen Material umfaßt, wobei das Wandelement eine strukturierte Oberfläche auf einer Seite und auf der anderen Seite eine der strukturierten Oberfläche gegenüberliegende glatte Oberfläche aufweist, wobei mindestens ein Teil des Querschnitts des Wandelementes in einer glatten gebogenen Kurve liegt, die strukturierte Oberfläche eine lineare Anordnung von im wesentlichen rechtwinkligen gleichschenkligen Prismen aufweist, die nebeneinander angeordnet sind, wobei die senkrechten Seiten der Prismen einen Winkel von ungefähr 45° mit der Tangente zu der der strukturierten Oberfläche gegenüberliegenden glatten Oberfläche bilden, so daß ein vorbestimmter Teil des in einem akzeptablen Winkelbereich in den Lichtleiter einfallenden Lichtes durch Totalreflexion festgehalten wird, wenn es vom proximalen Ende (140) zum distalen Ende (138) des Lichtleiters wandert.

8. Vorrichtung nach Anspruch 7, bei der das Wandelement im Querschnitt im wesentlichen kreisförmig ist, und die glatte Oberfläche auf der Innenseite des Wandelementes angeordnet ist, und die Prismen parallel zur Achse des Wandelementes verlaufen.

9. Vorrichtung (120) nach Anspruch 6, bei der das reflektierende Element (130) zwei oder mehr Abschnitte (32, 34, 36, 38) des reflektierenden Folienmaterials umfaßt, bei denen die Furchen (40) der linearen Anordnung von reflektierenden Elementen von einem der reflektierenden Folienabschnitte (38) nichtparallel zu den Furchen einer Anordnung von anderen Abschnitten (36) ausgerichtet sind, um das Licht in einem gleichmäßig verteilten Muster zu reflektieren.

10. Vorrichtung (120), die das Licht leitet und in einem breiten, gleichmäßigen Muster reflektiert, wobei die Vorrichtung folgendes umfaßt:
a) einen säulenartigen Lichtleiter (122) zur Beförderung des Lichtes, wobei der Lichtleiter ein proximales Ende (140) und ein distales Ende (138) aufweist;
b) eine Lichtquelle (144) am proximalen Ende des Lichtleiters; und
c) ein lichtverteilendes reflektierendes Element (130) mit einem spiegelnd reflektierenden Folienmaterial nach Anspruch 2, wobei das reflektierende Element am distalen Ende des Lichtleiters positioniert ist, so daß das am distalen Ende des Lichtleiters austretende Licht in einem breiten, gleichmäßig verteilten Muster reflektiert wird.

11. Vorrichtung (120) nach Anspruch 10, bei der das lichtverteilende reflektierende Element (130) ein reflektierendes Folienmaterial nach Anspruch 3 umfaßt.

12. Vorrichtung (120) nach Anspruch 6 oder 10, bei der es sich um einen Lichtmast mit einer Lichtquelle (144) handelt, die in einem Basisabschnitt (150) vorgesehen ist, der auf dem Boden angebracht oder im Boden eingelassen sein kann, wobei der säulenartige Lichtleiter (122) vertikal vom Boden ausgeht.

**Revendications**

1. Matériau à réflexion spéculaire en feuille (10) ayant une surface réfléchissante structurée qui comprend une série linéaire d'éléments réfléchissants en forme de prisme isocèle (12), chacun desdits éléments comportant deux surfaces réfléchissantes (14) qui forment entre elles un angle de 120° environ, chaque surface réfléchissante formant également une gorge réfléchissante (16) avec une surface réfléchissante adjacente, les surfaces de ladite gorge formant entre elles un angle de 120° environ.

2. Matériau à réflexion spéculaire en feuille (80) ayant une surface réfléchissante structurée qui comprend un ensemble d'éléments réfléchissants (82), chacun desdits éléments comportant un polyèdre à trois faces en parallélogramme (84,84',84") et étant configuré et agencé de façon à remplir les conditions suivantes :
   (a) lesdites faces se coupent suivant trois lignes extérieures d'intersection (86,86',86") et à un sommet d'élément (88),
   (b) chaque face est également en intersection avec les faces adjacentes de deux éléments adjacents ;
   (c) trois faces sur trois éléments adjacents se coupent le long de trois lignes intérieures d'intersection (90,90',90") pour former un creux de réflexion (92) ; et
   (d) en utilisation, un rayon de lumière incidente (100) qui entre dans le creux (92) et frappe une des trois faces suivant un angle de 33° à 37° environ est réfléchi par ladite face sensiblement parallèlement aux deux autres faces du creux et suivant un angle de 67° à 74° environ par rapport à la lumière incidente.

3. Matériau en feuille (80) suivant la revendication 2, dans lequel chacun desdits éléments (82) comprend un polyèdre ayant trois faces en losange (84, 84',84") et étant configuré et agencé de sorte que les conditions suivantes existent :
   (a) les dites faces en losange se coupent suivant trois lignes extérieures d'intersection (86,86',86") et à un sommet d'élément (88) ;
   (b) lesdites lignes extérieures d'intersection se rencontrent mutuellement au sommet, suivant des angles égaux;
   (c) chaque face en losange est également en intersection avec les faces adjacentes sur deux éléments adjacents;
   (d) les trois faces en losange de trois éléments adjacents se coupent le long de trois lignes intérieures d'intersection (90,90',90") pour former un creux de réflexion (92) ;
   (e) chaque face en losange forme un angle $\alpha$ avec le plan du matériau en feuille, $\alpha$ étant de 33° à 37° ;
   (f) en utilisation, un rayon de lumière incidente (100) perpendiculaire au plan du matériau en feuille est réfléchi par une des trois faces du creux, sensiblement parallèlement aux deux autres faces du creux ; et
   (g) l'angle $\beta$ entre un rayon de lumière incidente normale réfléchie (102) et le plan du matériau en feuille est de 16° à 23° environ.

4. Matériau en feuille suivant la revendication 3, dans lequel $\alpha$ est de 35° à 36° environ et $\beta$ est de 19° à 20° environ.

5. Chambre de réflexion (126) prévue pour réfléchir une source surfacique de lumière suivant une large configuration uniformément répartie, ladite chambre comprenant :
   (a) une entrée de lumière (128) ;
   (b) un réflecteur (130) comportant un matériau réfléchissant en feuille suivant la revendication 1 ou 2 ; et
   (c) au moins une partie de paroi transparente (134) pour permettre à la lumière réfléchie de sortir de la chambre de réflexion.

6. Appareil (120) pour le transport de lumière et la réflexion de la lumière en une large configuration uniforme, ledit appareil comprenant :
   (a) un conduit de lumière en colonne (122) pour transporter la lumière le long du conduit, ledit conduit ayant une extrémité proche (140) et une extrémité distante (138) ;
   (b) une source de lumière (144) prévue à l'extrémité proche du conduit de lumière ; et
   (c) un réflecteur de répartition de lumière (130) comprenant au moins une portion de matériau réfléchissant en feuille suivant la revendication 1, ledit réflecteur étant placé à l'extrémité distante (138) dudit conduit de lumière (122) de sorte que la lumière sortant de l'extrémité distante du conduit est réfléchie en une large configuration uniformément répartie.

7. Appareil (120) suivant la revendication 6, dans lequel ledit conduit de lumière en colonne (122) pour transporter la lumière le long du conduit comprend un élément de paroi en matière transparente, ledit élément de paroi présentant une surface structurée sur un côté et une surface lisse à l'opposé de ladite surface structurée, sur l'autre côté, au moins une partie de la section transversale dudit élément de paroi suivant une courbe en arc régulier, ladite surface structurée ayant une série linéaire de prismesisocèles sensiblement à angle droit disposés côte à côte, les faces perpendiculaires desdits prismes formant un angle de 45° environ avec la tangente à ladite surface lisse à l'opposé de ladite surface structurée, de sorte qu'une portion prédéterminée de la lumière entrant dans le conduit de la lumière à l'intérieur d'une plage angulaire acceptable est

contenue par réflexion interne totale pendant son parcours de l'extrémité proche (140) à l'extrémité distante (138) du conduit de lumière.

8. Appareil suivant la revendication 7, dans lequel ledit élément de paroi est sensiblement circulaire en section transversale et ladite surface lisse est disposée du côté intérieur dudit élément de paroi, et les dits prismes s'étendent parallèlement à l'axe dudit élément de paroi.

9. Appareil (120) suivant la revendication 6, dans lequel ledit réflecteur (130) comprend deux parties ou plus (32,34,36 ,38) dudit matériau réfléchissant en feuille, dans lesquelles les gorges (40) de la série linéaire d'éléments réfléchissants d'une desdites portions de matériau réfléchissant en feuille (38) sont alignées en relation non parallèle aux gorges d'une série d'une autre portion (36), afin de réfléchir la lumière en une configuration uniformément répartie.

10. Appareil (120) pour transporter la lumière et réfléchir la lumière en une large configuration uniforme, ledit appareil comprenant :

1. un conduit de lumière en colonne (122) pour transporter la lumière le long du conduit, ledit conduit ayant une extrémité proche (140) et une extrémité distante (138) ;

2. une source de lumière (144) prévue à l'extrémité proche du conduit de lumière ; et

3. un réflecteur de répartition de lumière (30) comprenant un matériau à réflexion spéculaire en feuille suivant la revendication 2, ledit réflecteur étant placé à l'extrémité distante dudit conduit de lumière de sorte que la lumière sortant de l'extrémité distante du conduit est réfléchie en une large configuration uniformément répartie.

11. Appareil (120) suivant la revendication 10, dans lequel le réflecteur de répartition de lumière (130) comprend un matériau réfléchissant en feuille suivant la revendication 3.

12. Appareil (120) suivant la revendication 6 ou 10, qui est un lampadaire comprenant une source de lumière (144) prévue dans une partie de base (150) qui peut être enterrée dans le sol ou placée sur le sol, le conduit en colonne (122) s'étendant verticalement à partir du sol.

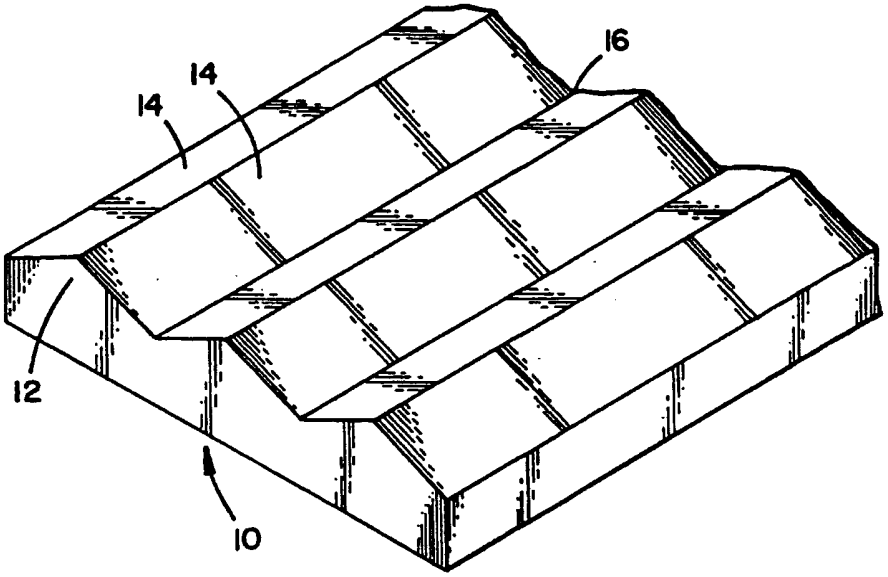



FIG. 1

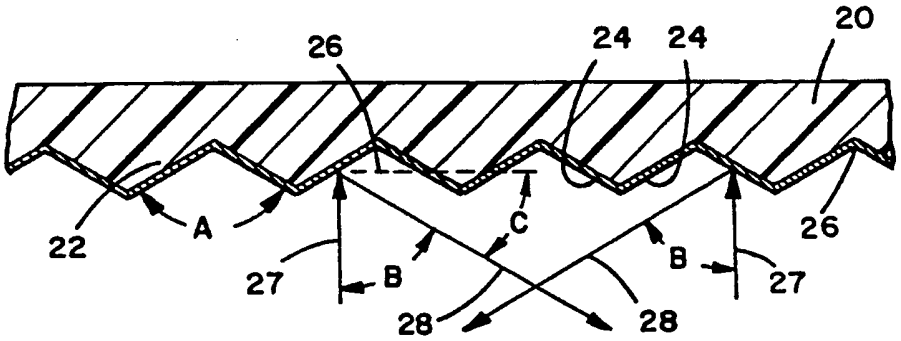



FIG. 2

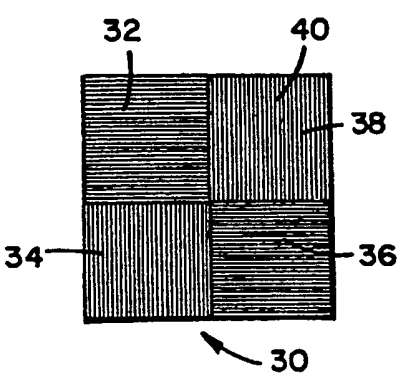



FIG. 3A

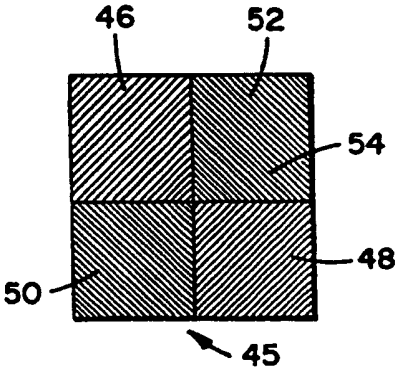



FIG. 3B

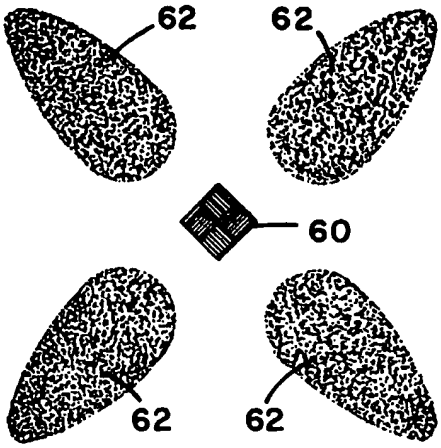



FIG. 4

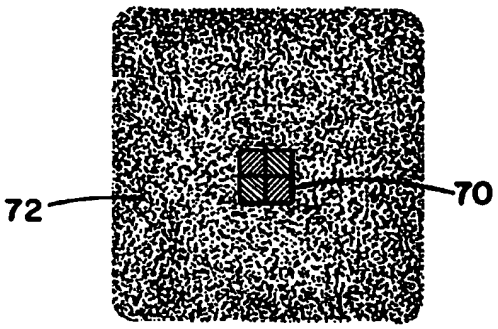



FIG. 5

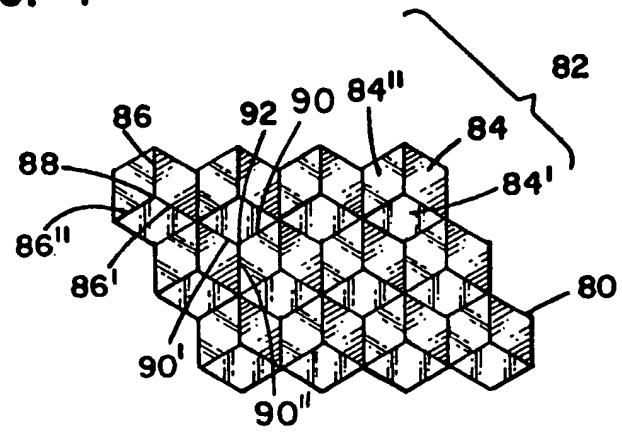
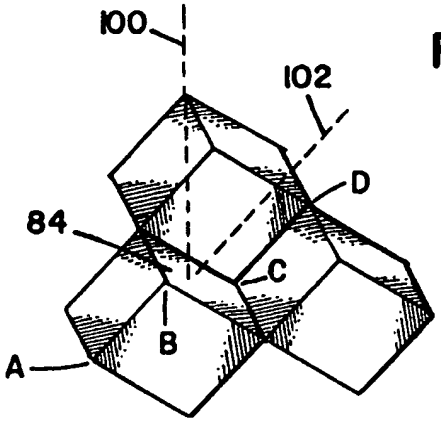



FIG. 6



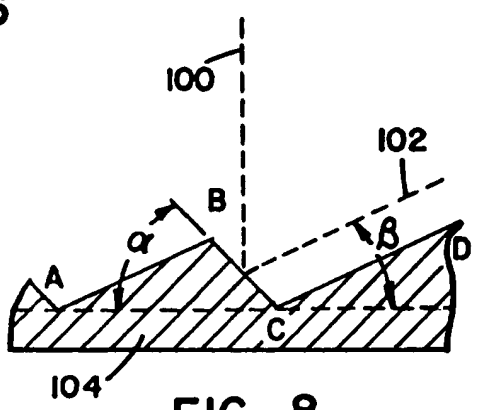
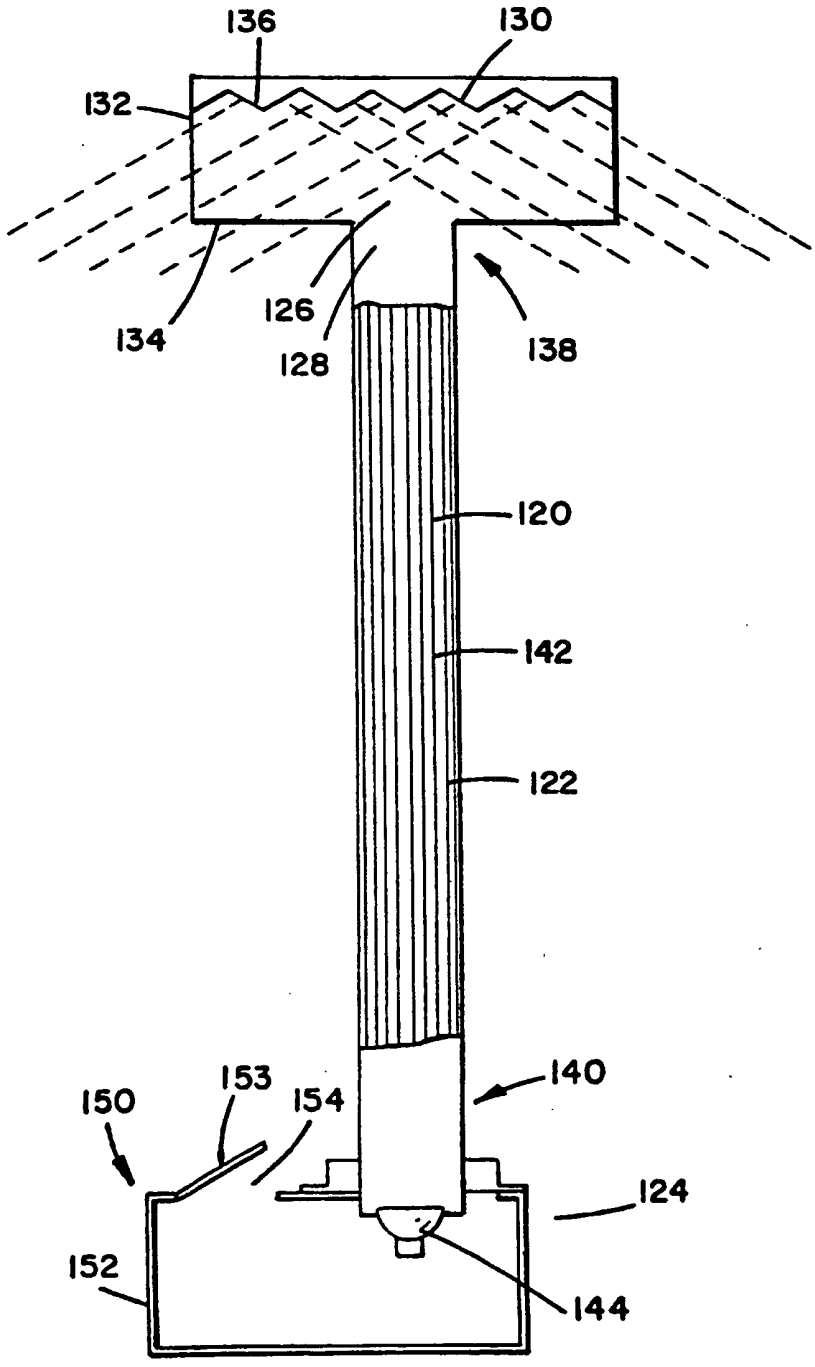




FIG. 8

FIG. 7

FIG. 9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